Cloud and Precipitation Process Measurement Concept

Partnership Options

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Examples of Mission Concepts

Single Spacecraft	Multiple Spacecraft		Multiple Smallsats		Multiple Smallsats and Cubesats	
KuKaW+mw	Platform A	KuKa traditional free flyer or smallsat	Platform A (x4)	Ku small sats	Platform A	KuW smallsat
	Platform B	W smallsat	Platform B	KaW small sat	Platform B	Ka smallsat (x2)
	Platform C	μw freeflyer or smallsat	Platform C	μw smallsat	Platform C	Sounder
					Platform D	submm

These concepts can be further developed and evaluated based on candidate sensors currently under development or planned for near term development.

Options

Identification of Potential Instrument Areas for Joint Collaboration (Case study)

	Case 1	Case 2	Case 3	Case 4
W band radar	NASA	NASA	NASA	NASA
Ka band radr	NASA	JAXA	—	RainCube
Ku band radr	JAXA	JAXA	JAXA	JAXA

Microwave Imager	NASA or JAXA

Satellite bus	NASA or JAXA

Launch	NASA or JAXA

CAPPM-related Instrument Concepts*

Radar Instruments	Conical Microwave Imager Instruments	mm/Sub-mm radiometer/sounder
JAXA DPR-2 KuKa	GMI #2	MASC (Microwave Atmospheric Sounder for Cubesat)
JPL Ka Raincube	COWVR FO (Compact Ocean Wind Vector Radiometer)	IceCube (874 GHz)
JAXA Ku small sats		SWIRP Compact Submm-Wave and LWIR Polarimeters for Cirrus Ice Properties
JPL MASTR Multi Application Smallsat Tri-Band Radar		SAPHIR NG MW sounder
ACE-class Ka/W or Ku/Ka/W Doppler active scanning radar (GSFC-NG & JPL-Nuvotronics-Raytheon solutions)		TWICE Wide-band Millimeter and Sub-Millimeter Wave Radiometer Instrument to Measure Tropospheric Water and Cloud ICE

*This is not an exhaustive survey of all instrument concepts but reflects inputs provided to the CAPPM working group.

Instrument Readiness for Constellation Implementation (1)

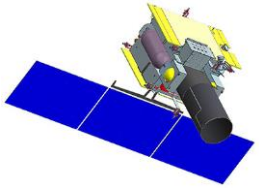
- Now:
  - RainCube (JPL) – 6U, Ka-band radar with 0.5m antenna and 1 nadir beam
  - RainCube2 (JPL) – in one-web-class bus, 0.75-0.8m fix antenna dish with 3-4 beams
    - Two RainCubes for Doppler meas.
  - COVWR (JPL) as is – 150-kg class smallsat. It has a radiometer with smaller antenna
  - MASC and/or TEMPEST-D (JPL) – 6-U cubesat with multi-channel radiometer
  - IceCube (GSFC) – 3-U cubesat with in submillimeter-wave radiometer
  - GMI #2 (GSFC)
  - JAXA Ku radar constellation – four (4) 500-kg class smallsats with Ku-band wide cross-track scanning radar
  - On-orbit missions (Mega-T, GPM, etc)
  - OceanSAT-3 mission (ISRO) – Scatterometer + SST + ocean color (2020 launch)
  - ESA atmos missions + EarthCARE

Instrument Readiness for Constellation Implementation (2)

- Now + 3yrs:
  - MASTR (JPL) - Ka/W-band radar with 1-m scanning antenna and Doppler
  - CloudCube (JPL) – RainCube at W-band, 0.75-0.8m fix antenna with scanning
  - COVWR with larger hybrid mesh antenna
  - SWIRP (GSFC) – 12-U cubesat with IceCube & LWIR as payloads
  - TSU/HSU (ISRO) – temperature/humidity microwave sounders
  - TWICE (CSU/JPL) – 6U cubesat with a 15-channel radiometer spanning 118-670GHz for ice, temp, hum. sounding

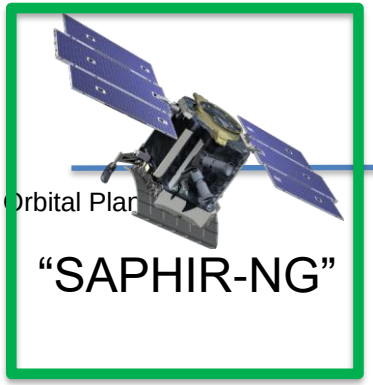
- Now + 5yrs:
  - MASTR-2 (JPL) - Ku/Ka/W-band radar with with 1m+ scanning antenna and Doppler
  - SAPHIR-NG (CNES) - 6-channel microwave sounder in microsat

Notional Distributed Train Concept



GEO

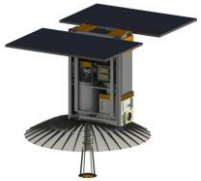
- 500 km altitude
- 30 deg inclination



Orbital Plan

"SAPHIR-NG"

ASPRC (Ku radar)



TWICE/SWI
RP/TSU/HSU

MASTR 1
(Ka/W)

RainCube

RainCube1-2

Orbital

COWVR
0M

IceCube/TWICE/
SWIRP/TSU/HSU